

ECET Senior Project Report

Substation SCADA

Submitted to

Professor Cooney

by

Kyle Swaby

August 7, 2017

Revision History

Date	Initials	Version	Notes
5/15/2017	KS	1.1	Initial
6/6/2017	KS	1.2	Added Standards Section, Figures
7/6/2017	KS	1.3	Adjusted After TCM 499 Pier Review
8/6/17	KS	1.4	Added TCM 499 Recommendations

Abstract

This report will go over the project that was completed as the ECET graduation project. This project involves designing a system that will gather data from various devices in a substation. This data was manipulated and gathered by an RTU. The project was due to an electric cooperative replacing their analog recloser controls with new digital controls. This allowed for advanced monitoring and controlling of the devices. The paper will show examples of the design, wiring, and programming of the system.

Table Of Contents

1. An introduction and overview of the project.
 - 1.1. Thesis: The more data and devices that are seen is SCADA will help predict load growth and respond to issues quickly.
2. The hardware that will stand up to the elements.
 - 2.1. The devices that were used in the project.
 - 2.2. The layout of devices in the RTU.
3. The software programming of the devices.
 - 3.1. The programming of the RTU.
 - 3.2. Programming the end devices.
4. The standards that are involved.
5. The project capitalization.
6. The project testing procedure.
7. Conclusion and lessons learned from the project.
8. A list of references used in the project report.

List Of Figures

Figure 1 – SCADA Communications Flow	4
Figure 2 – Cabinet Layout	6
Figure 3 – Scaling Chart	7

Substation SCADA

1. Preview of the Project

The project involved designing a system of devices that gathers data from various controls in a substation and will be able to issue commands and do calculations with the data. The communications protocols that was used is DNP3 and Quantum. The cabinet was also replaced and had to be NEMA 4X rated cabinet.

1.1. The more data and devices that are seen in SCADA will help predict load growth and respond to issues quickly.

The data that is gathered from the devices will be used to verify what devices are open or closed. This will help is response times and being able to accurately know where the faults are. Figure 1 shows the overview of the communications of the system.

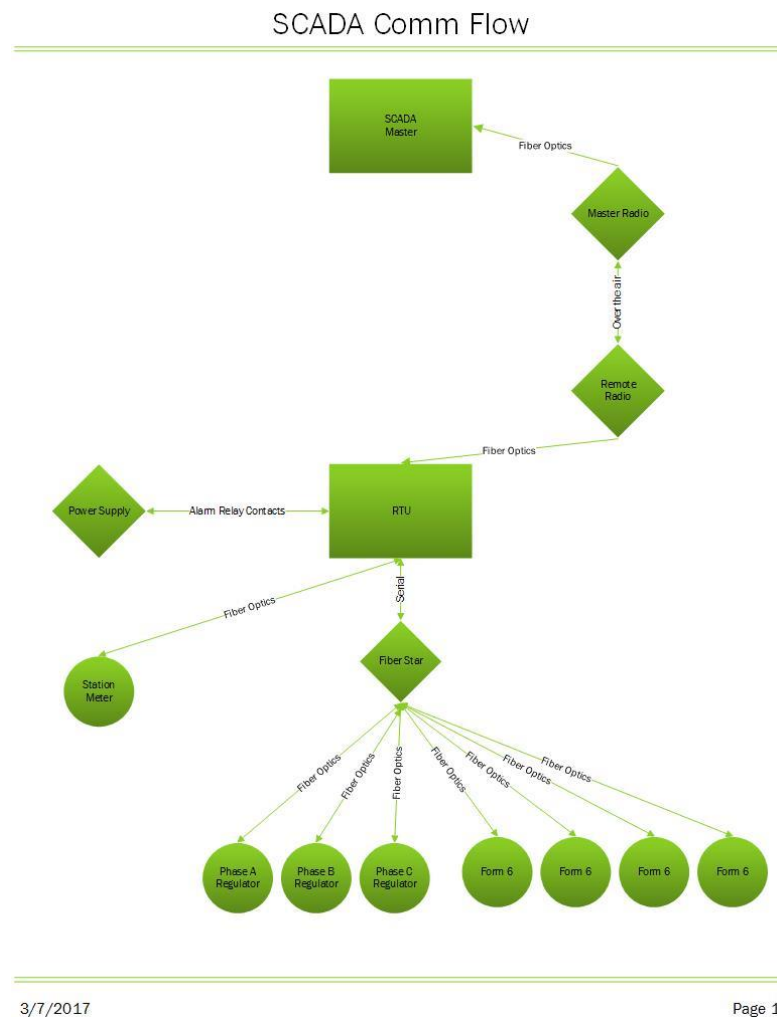


Figure 1

2. The hardware that will stand up to the elements.

The design and selection of the components used played a crucial part in the system. They all had to be rated to operate at -40 to +70C. I used fiber optics between the devices as much as possible to isolate them and prevent as much damage in case of lightning or other issues. The design of the system was changed last minute due to a control house being installed. Since the RTU was moved to the control house, all of the conduit and wires had to be redone. This made the project get behind schedule by a couple days.

2.1. The Devices used in the Project

The devices that were used in the project are listed below;

- 4 – SEL 2812
- 1 – Sage 2400 RTU
- 1 – Dymec Fiber Star
- 1000' Multimode Fiber
- 50 – ST Fiber connectors
- 1 – 24 Fiber Patch Panel
- 1 – Phoenix Contact 48VDC to 24VDC Supply
- 1 – Rhino 24VDC to 12VDC Convertor
- 1 – NEMA 4X 42x36x16 Enclosure

These devices are rated to work at temperatures in the ranges of -40 to +70C and in +95% humidity. Originally, the main power coming in the RTU was going to be 120VAC but since the RTU was relocated in the control house I decided to use the 48 VDC battery bank. This will allow the equipment to utilize the larger battery bank and the backup generator. This also made me redesign the power supply setup to use the 48VDC. I wanted to stay with Phoenix Contact supplies and they offered a 48 to 24VDC power supply. It also had the same alarming configuration as the 120VAC version. I also used SEL-2812 serial to fiber converters for the radio and meter fiber runs. These devices are port powered, utilizing the 5VDC pin of the RS-232 port. This cut down on wiring and allowed for a simplified setup versus a separate 12VDC powered device.

2.2. The Layout of the Devices

The layout of the cabinet was designed so that parts could be changed out easily and that troubleshooting could be done easily and quickly. To accommodate future devices wire duct was used. Figure 2 shows the cabinet with the devices and wiring.

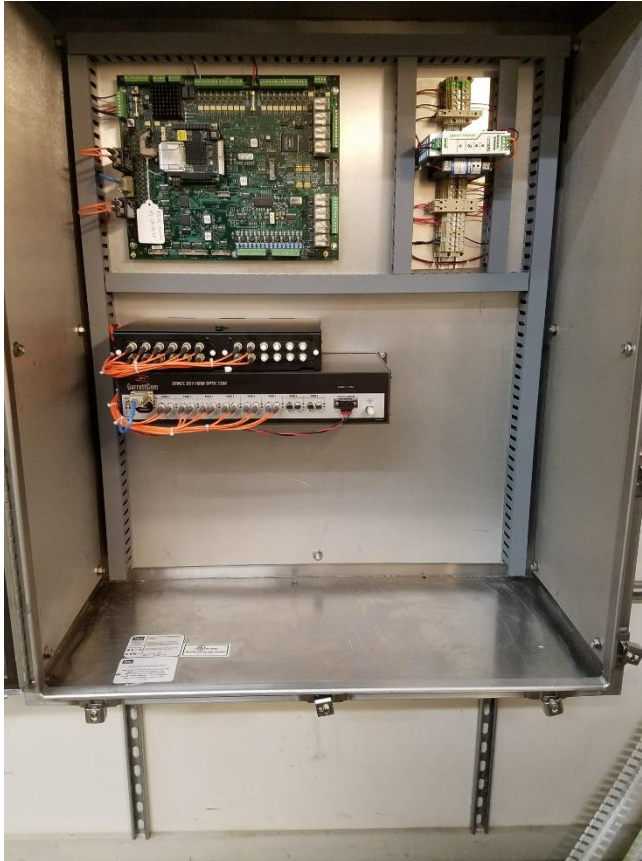


Figure 2

Since the cabinet is in a control house no heater was needed. This eliminated the need for 120VAC in the cabinet.

3. The software programming of the devices.

The programming of the devices is the most important part of the project. If things are not aligned properly then the values you are getting will not match with what is expected. For example if you are getting a value of 325 for what is supposed to be voltage, this value is not correct; it might be the current value. Everything has to line up exactly for things to work properly.

3.1. The programming of the RTU.

The programming of the RTU was done before the install to cut down on install times. When programming the RTU the point indexing had to be correct and had to match the point index of the controls that were being scanned. The address of each device had to be different from each other. The baud rate, bit count, and parity all had to match in each device also. Indication LED's are on every port and help in troubleshooting. Calculations were made to show the correct values of KW and KVAR by using the meter multiplier. For example, if a meter has a multiplier of 1200 this had to be multiplied by the raw KW value before being sent to the SCADA system. This was done for KW and KVAR. The scale factors for non-calculated points are set to -32767 to 32767. This allowed the full range to be displayed.

IED Name					
Name	C Min	C Max	EGU Min	EGU Max	IED Point
CG2 Ph. A Amp	-32767	32767	-32767	32767	0
CG2 Ph. B Amp	-32767	32767	-32767	32767	1
CG2 Ph. C Amp	-32767	32767	-32767	32767	2

Figure 2

The controls are programmed just like the analogs. They have to have the correct index number to work. They also have to have the correct control type, for example latching versus pulse. The index numbers also have to be correct for the status points and accumulators.

3.2. Programming the end devices.

The controls had to be programmed so that each control has a different address but the same baud rate. This was done on all 6 controls. Each control had extra points that were programmed, which added to the default points. This was accounted for when the RTU was programmed. Also the RTU had to have the correct address so that the SCADA system could scan it correctly. The meter was a protocol so it had to be scanned from a different port. The same principles applied, the indexes had to line up with what is expected.

4. The standards that are involved.

Many standards are involved in substations and SCADA. The cabinet needed to be rated as a NEMA 4X cabinet. This means that the cabinet will be protected from splashing water, rain, and snow, and against corrosion. The hardware and all devices need to be rated to operate at temperatures at -40 to +70C. This will help to ensure that the extreme temperatures will not have an effect on the operation of the devices. The communications between the devices will use DNP protocol unless device is unable too. It will also use fiber optics as the communications path. The most important standard that was part of the project was safety. At all times the proper PPE (Personal Protective Equipment) was worn. These standards were implemented to ensure the project was done safely and will last.

5. The project capitalization

	Quantity	Price/Each	Total
NEMA 4X RTU cabinet	1	1300	1300
RTU	1	5030	5030
Fiber Star	1	1860	1860
Fiber	1000	0.45	450
Medium Patch Panel	1	203	203
1M Fiber Patch Cables	5	1.4	7
2M Fiber Patch Cables	5	2.7	13.5
Wire Tray	3	10.5	31.5
Fiber Connectors	50	10.6	530
SEL 2505	2	680	1360

Conduit and Misc Fittings		100	100
Power Supply	1	718.1	718.1
Total		11603.1	

6. The project testing procedure.

Field Test List

Task	Status	Start Date	% Complete	Notes
120VAC	Complete	5/26/2017	100%	
24VDC	Complete	5/26/2017	100%	
12VDC	Complete	5/26/2017	100%	
Heater	Deferred	5/26/2017	100%	
Fiber Tested	Complete	5/26/2017	100%	
RTU Analogs Inputs	Complete	5/26/2017	100%	
RTU Binaries Inputs	Complete	5/26/2017	100%	
RTU Binaries Outputs	Complete	5/26/2017	100%	

7. Conclusion and lessons learned from the project.

The project changed from the initial talks. These changes made it more difficult to install and required more time. It did in the end produce a cleaner and better install. I did learn how to utilize Microsoft Projects from this course and plan to use during other project.

8. References

Stark, Dan (2008). Web Applications. Retrieved from www.Schneider-eletric.com

National Electrical Manufacturers Association. (2005). NEMA Enclosure Types. Rosslyn, VA.